#### Санкт-Петербургский политехнический университет Петра Великого Институт компьютерных наук и технологий Высшая школа программной инженерии



### Получение выходного сигнала с помощью КИХ-фильтра

Расчетное задание №2 по курсу Цифровая обработка и передача многомерных сигналов

Вариант № 7

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### Задание

Есть импульсный отклик ЛИС-системы  $h(n_1, n_2)$ . Необходимо найти реакцию системы на входной сигнал  $x(n_1, n_2)$  двумя способами:

- 1) с помощью дискретной свертки:  $y(n_1, n_2) = h(n_1, n_2) ** x(n_1, n_2);$
- 2) путем суммирования взвешенных и сдвинутых импульсных откликов;

$$h(n_1, n_2) = \begin{pmatrix} 3 & 3 & 2 & 2 & 1 & 1 & 2 \\ 1 & 1 & 4 & 3 & 3 & 2 & 0 \\ 2 & 2 & 3 & 4 & 0 & 5 & 4 \\ 2 & 4 & 3 & 3 & 2 & 1 & 0 \\ 0 & 4 & 2 & 0 & 3 & 6 & 5 \\ 0 & 3 & 2 & 4 & 7 & 5 & 7 \\ 0 & 3 & 3 & 0 & 4 & 4 & 7 \end{pmatrix} \xrightarrow{n_1}$$

$$x(n_1, n_2) = \begin{pmatrix} 0 & 3 & 3 & 0 & 5 & 0 & 0 \\ 4 & 2 & 2 & 4 & 0 & 4 & 4 \\ 5 & 3 & 2 & 5 & 3 & 4 & 7 \\ 5 & 4 & 2 & 0 & 0 & 4 & 0 \\ 0 & 4 & 1 & 4 & 0 & 0 & 8 \\ 3 & 3 & 2 & 0 & 2 & 4 & 5 \\ 0 & 1 & 3 & 4 & 0 & 4 & 6 \\ 0 & 4 & 0 & 5 & 5 & 0 & 0 \end{pmatrix} \xrightarrow{n_1}$$

# Подготовительный этап

Определим размер выходной матрицы у. Пусть h имеет размерность N 1 x N 2, a x - M 1 x M 2 . Тогда размерность матрицы у - L 1 x L 2 будет:

$$L 1 = N 1 + M 1 - 1 = 7 + 8 - 1 = 14$$
  
 $L 2 = N 2 + M 2 - 1 = 7 + 7 - 1 = 13$ 

### Текст программы

Программы для вычисления реакции системы написаны на языке C++ 11, в среде разработки Qt Creator 5.9.2. Программа для визуализации данных написана с использованием среды MatLab R2016a.

### 1) Вычисление дискретной свертки

```
#include <stdio.h>

#define H_ROW 7
#define H_COL 7
#define X_ROW 8
#define X_COL 7
#define Y_ROW (H_ROW + X_ROW - 1)
#define Y_COL (H_COL + X_COL - 1)

void PrintMatrix(FILE* file, int* matrix[], const char* type)
```

```
{
                   int row, col;
                    if (type == "H")
                                        row = H_ROW;
                                       col = H_COL;
                    } // (type == "H")
else if (type == "X")
                                        row = X_ROW;
                                        col = X_COL;
                    } // (type == "X")
                    else
                                        row = Y_ROW;
                                        col = Y_COL;
                    } // (type != "X") && (type != "H")
                    fprintf(file, "====== Matrix %s(%d, %d)======\n", type, row, col);
                    for (int i = 0; i < row; i++)
                                        for (int j = 0; j < col; j++)
                                                            fprintf(file, "%d\t", matrix[i*col + j]);
                                        } // for (int j = 0; j < col; j++)
                                        fprintf(file, "\n");
                    } // for (int i = 0; i < row; i++)
                    fprintf(file, "\n\n");
}
int main()
                    int h[H_ROW][H_COL] = \{ \{ 3, 3, 2, 2, 1, 1, 2 \},
                                                                                                                                             { 1, 1, 4, 3, 3, 2, 0 },
                                                                                                                                                2, 2, 3, 4, 0, 5, 4 },
                                                                                                                                                 2, 4, 3, 3, 2, 1, 0 },
                                                                                                                                                 0, 4, 2, 0, 3, 6, 5 },
                                                                                                                                             { 0, 3, 2, 4, 0, 5, 7 },
                                                                                                                                            { 0, 3, 3, 0, 4, 4, 7 } };
                    int x[X_ROW][X_COL] = \{ \{ 0, 3, 3, 0, 5, 0, 0 \},
                                                                                                                                             { 4, 2, 2, 4, 0, 4, 4 },
                                                                                                                                                5, 3, 2, 5, 3, 4, 7 },
                                                                                                                                                5, 4, 2, 0, 0, 4, 0 },
                                                                                                                                                0, 4, 1, 4, 0, 0, 8 },
                                                                                                                                             { 3, 3, 2, 0, 2, 4, 5 },
                                                                                                                                            { 0, 1, 3, 4, 0, 4, 6 },
                                                                                                                                             { 0, 4, 0, 5, 5, 0, 0 } };
                    int y[Y_ROW][Y_COL];
                    for (int i = 0; i < Y_ROW; i++)
                    {
                                        for (int j = 0; j < Y_COL; j++)
                                                           y[i][j] = 0;
                    } // for(int j = 0; j < Y_COL; j++)
} // for(int i = 0; i < Y_ROW; i++)</pre>
                    for (int i = 0; i < Y_ROW; i++)
                                        for (int j = 0; j < Y_COL; j++)
                                                            for (int k1 = 0; k1 < H_ROW; k1++)
                                                                                for (int k2 = 0; k2 < H_COL; k2++)
                                                                                {
                                                                                                    if ((i - k1 \ge 0) \&\& (i - k1 < X_ROW) \&\& (j - k2 < X_COL) \&\& (j - k2 < X_COL) && (j -
k2 >= 0)
                                                                                                    {
                                                                                                                       y[i][j] += h[k1][k2] * x[i - k1][j - k2];
                                                                                                    } // if((i-k1 >= 0)&&(i-k1 < X_ROW)&&(j-k2 < X_COL)&&(j-k2 >= 0))
                                                                                } // for(int k2 = 0; k2 < H_COL; k2++)
                                                            } // for(int k1 = 0; k1 < H_ROW; k1++)
```

```
} // for(int j = 0; j < Y_COL; j++)
} // for(int i = 0; i < Y_ROW; i++)

FILE* file = fopen("../method_1.xls", "w");

if (file != NULL)
{
          PrintMatrix(file, (int**)h, "H");
          PrintMatrix(file, (int**)x, "X");
          PrintMatrix(file, (int**)y, "Y");

          fclose(file);
} // if(file != NULL)

return 0;
}</pre>
```

#### 2) Суммирование взвешенных и сдвинутых импульсных откликов

```
#include <stdio.h>
#define H_ROW 7
#define H_COL 7
#define X_ROW 8
#define X_COL 7
\#define Y_ROW (H_ROW + X_ROW - 1)
#define Y_COL (H_COL + X_COL - 1)
void PrintMatrix(FILE* file, int* matrix[], const char* type)
{
        int row, col;
        if (type == "H")
                 row = H_ROW;
                 col = H_COL;
        } // (type == "H")
else if (type == "X")
                 row = X_ROW;
                 col = X_COL;
         } // (type == "X")
         else
                 row = Y_ROW;
col = Y_COL;
        } // (type != "X") && (type != "H")
        fprintf(file, "====== Matrix %s(%d, %d)======\n", type, row, col);
         for (int i = 0; i < row; i++)
                 for (int j = 0; j < col; j++)
                          fprintf(file, "%d\t", matrix[i*col + j]);
                 } // for (int j = 0; j < col; j++)</pre>
                 fprintf(file, "\n");
        } // for (int i = 0; i < row; i++)
        fprintf(file, "\n\n");
}
int main(void)
        int h[H_ROW][H_COL] = \{ \{ 3, 3, 2, 2, 1, 1, 2 \},
                                                             { 1, 1, 4, 3, 3, 2, 0 },
                                                             { 2, 2, 3, 4, 0, 5, 4 },
                                                              2, 4, 3, 3, 2, 1, 0 },
                                                             { 0, 4, 2, 0, 3, 6, 5 },
                                                             { 0, 3, 2, 4, 0, 5, 7 },
                                                             { 0, 3, 3, 0, 4, 4, 7 } };
        int x[X_ROW][X_COL] = \{ \{ 0, 3, 3, 0, 5, 0, 0 \},
                                                             { 4, 2, 2, 4, 0, 4, 4 },
                                                             { 5, 3, 2, 5, 3, 4, 7 },
                                                             { 5, 4, 2, 0, 0, 4, 0 },
```

```
{ 0, 4, 1, 4, 0, 0, 8 },
                                                        { 3, 3, 2, 0, 2, 4, 5 },
                                                        { 0, 1, 3, 4, 0, 4, 6 },
                                                        { 0, 4, 0, 5, 5, 0, 0 } };
int temp[Y_ROW][Y_COL];
int y[Y_ROW][Y_COL];
for (int i = 0; i < Y_ROW; i++)
{
         for (int j = 0; j < Y_COL; j++)
                  y[i][j] = 0;
} // (int j = 0; j < Y_COL; j++)
} // (int i = 0; i < Y_ROW; i++)
FILE* file = fopen("method_2.xls", "w");
PrintMatrix(file, (int**)h, "H");
PrintMatrix(file, (int**)x, "X");
for (int k1 = 0; k1 < X ROW; k1++)
         for (int k2 = 0; k2 < X_COL; k2++)
                  for (int i = 0; i < Y_ROW; i++)
                            for (int j = 0; j < Y_COL; j++)
                                     temp[i][j] = 0;
                  } // for (int j = 0; j < Y_COL; j++)
} // (int i = 0; i < Y_ROW; i++)
                   for (int m1 = 0; m1 < H_ROW; m1++)
                            for (int m2 = 0; m2 < H_COL; m2++)
                                     temp[m1 + k1][m2 + k2] = h[m1][m2] * x[k1][k2];
                            } // (int m2 = 0; m2 < H_COL; m2++)</pre>
                  } // (int m1 = 0; m1 < H_ROW; m1++)</pre>
                  char matr[12] = "";
                  sprintf(matr, "Temp_%d_%d", k1 + 1, k2 + 1);
                  PrintMatrix(file, (int**)temp, matr);
                  for (int i = 0; i < Y_ROW; i++)
                            for (int j = 0; j < Y_COL; j++)
                                     y[i][j] += temp[i][j];
                  } // (int j = 0; j < Y_COL; j++)
} // (int i = 0; i < Y_ROW; i++)
         \frac{1}{2} // (int k2 = 0; k2 < X_COL; k2++)
\frac{1}{2} // (int k1 = 0; k1 < X_ROW; k1++)
PrintMatrix(file, (int**)y, "Y");
fclose(file);
```

### 3) Построение 3D графиков реакции системы.

```
function [] = plot_out_signals()
% % PLOT_OUT_SIGNALS
% Summary of this function goes here.
%
% * Syntax
%
% [] = PLOT_OUT_SIGNALS()
%
% * Input
%
% -- INPUTARGS -
%
% * Output
```

}

```
% -- OUTPUTARGS -
% * Examples:
%
% Provide sample usage code here
% * See also:
% List related files here
% * Author: Dmitrii Leliuhin
% * Email: dleliuhin@mail.ru
% * Date: 31/03/2019 15:18:11
% * Version: 1.0 $
% * Requirements: PCWIN64, MatLab R2016a
% * Warning:
%
% # Warnings list.
%
% * TODO:
%
% # TODO list.
%% Code
clc;
clear all;
close all;
y.rows = 14;
y.cols = 13;
file\_name\_1 \ = ".../results/method\_1.xls";
file_name_2 = '../results/method_2.xls';
Y_1 = zeros(y.rows, y.cols);
Y_2 = zeros(y.rows, y.cols);
xls_range_1 = 'A23:M36';
xls_range_2 = 'A975:M988';
Y_1 = xlsread(file_name_1, xls_range_1);
Y_2 = xlsread(file_name_2, xls_range_2);
title('Метод 1. Вычисление дискретной свертки.', 'FontSize', 18);
surf(Y_1)
saveas(gcf, '../results/method_1', 'jpg');
figure;
title('Метод 2. Суммирование взвешенных и сдвинутых импульсных откликов.', ...
   'FontSize', 18);
saveas(gcf, '../results/method_2', 'jpg');
figure;
surf(Y_1);
view(2);
snapnow;
saveas(gcf, '../results/2D-view', 'jpg');
save('../results/workspace.mat');
close all;
end
```

# Результаты

### 1) Вычисление дискретной свертки

	$y(n_1, n_2)$													
0	9	18	15	27	24	16	19	11	5	10	0	0		
12	21	26	45	50	53	79	51	39	30	8	12	8		
19	36	57	78	100	105	124	131	82	80	57	23	14		
28	53	91	113	107	160	160	125	137	80	53	58	16		
23	57	102	151	133	171	220	188	162	149	85	63	44		
29	82	109	144	162	217	261	270	195	129	146	96	30		
13	77	119	161	175	221	323	272	290	230	152	174	107		
6	80	116	143	194	249	357	330	242	233	177	188	97		
6	54	99	125	147	209	293	311	264	158	143	183	113		
0	37	75	88	133	139	268	243	142	171	101	124	81		
0	17	47	75	95	111	137	226	153	95	108	141	121		
0	9	37	34	60	92	126	139	151	131	95	106	77		
0	0	15	20	52	41	78	113	80	104	75	52	42		
0	0	12	12	15	46	31	48	40	55	35	0	0		

### 2) Суммирование взвешенных и сдвинутых импульсных откликов

$h(n_1, n_2) * x(8,1)$														
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		

$h(n_1, n_2) * x(8,2)$														
0	9	9	6	6	3	3	6	0	0	0	0	0		
0	3	3	1	9	9	6	0	0	0	0	0	0		
			2											
0	6	6	9	1	0	1	1	0	0	0	0	0		
_				2		5	2	_	_	_	_	_		
0	6	1 2	9	9	6	3	0	0	0	0	0	0		
0	0	1	6	0	9	1	1	0	0	0	0	0		
		2				8	5							
0	0	9	6	1	0	1	2	0	0	0	0	0		
				2		5	1							
0	0	9	9	0	1	1	2	0	0	0	0	0		
					2	2	1							
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		

$h(n_1$	$, n_{2})$	*x(8,3)	3)

0	0	9	9	6	6	3	3	6	0	0	0	0
0	0	3	3	1 2	9	9	6	0	0	0	0	0
0	0	6	6	9	1 2	0	1 5	1 2	0	0	0	0
0	0	6	1 2	9	9	6	3	0	0	0	0	0
0	0	0	1 2	6	0	9	1 8	1 5	0	0	0	0
0	0	0	9	6	1 2	0	1 5	2	0	0	0	0
0	0	0	9	9	0	1 2	1 2	2	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

$h(n_1, n_2) * x(8,4)$														
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		

$$h(n_1, n_2) * x(8,5)$$

0	0	0	0	1	1	1	1	5	5	1	0	0
				5	5	0	0			0		
0	0	0	0	5	5	2	1	1	1	0	0	0
						0	5	5	0			
0	0	0	0	1	1	1	2	0	2	2	0	0
				0	0	5	0		5	0		
0	0	0	0	1	2	1	1	1	5	0	0	0
				0	0	5	5	0				
0	0	0	0	0	2	1	0	1	3	2	0	0
					0	0		5	0	5		
0	0	0	0	0	1	1	2	0	2	3	0	0
					5	0	0		5	5		
0	0	0	0	0	1	1	0	2	2	3	0	0
					5	5		0	0	5		
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

	$h(n_1, n_2) * x(8, 6)$														
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			

$h(n_1, n_2) * x(7,1)$														
0	0	0	0	0	0	0	0	0	0	0	0	0		
1	1	8	8	4	4	8	0	0	0	0	0	0		
2	2													
4	4	1	1	1	8	0	0	0	0	0	0	0		
		6	2	2										
8	8	1	1	0	2	1	0	0	0	0	0	0		
		2	6		0	6								
8	1	1	1	8	4	0	0	0	0	0	0	0		
	6	2	2											
0	1	8	0	1	2	2	0	0	0	0	0	0		
	6			2	4	0								
0	1	8	1	0	2	2	0	0	0	0	0	0		
	2		6		0	8								
0	1	1	0	1	1	2	0	0	0	0	0	0		
	2	2		6	6	8								
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		

	$h(n_1, n_2) * x(7, 2)$														
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	6	6	4	4	2	2	4	0	0	0	0	0			
0	2	2	8	6	6	4	0	0	0	0	0	0			
0	4	4	6	8	0	10	8	0	0	0	0	0			
0	4	8	6	6	4	2	0	0	0	0	0	0			
0	0	8	4	0	6	12	10	0	0	0	0	0			
0	0	6	4	8	0	10	14	0	0	0	0	0			
0	0	6	6	0	8	8	14	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

	$h(n_1, n_2) * x(8,7)$													
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		

							0						
ſ	0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(7,3	3)						
0         0														
0	0	6	6	4	4	2	2	4	0	0	0	0		
0	0	2	2	8	6	6	4	0	0	0	0	0		
0	0	4	4	6	8	0	10	8	0	0	0	0		
0	0	4	8	6	6	4	2	0	0	0	0	0		
0	0	0	8	4	0	6	12	10	0	0	0	0		
0	0	0	6	4	8	0	10	14	0	0	0	0		
0	0	0	6	6	0	8	8	14	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		

		h	$(n_1)$	$, n_2$	) * 2	χ(7,	4)					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1 2	1 2	8	8	4	4	8	0	0	0
0	0	0	4	4	1 6	1 2	1 2	8	0	0	0	0
0	0	0	8	8	1 2	1 6	0	2 0	1 6	0	0	0
0	0	0	8	1 6	1 2	1 2	8	4	0	0	0	0
0	0	0	0	1 6	8	0	1 2	2 4	2 0	0	0	0
0	0	0	0	1 2	8	1 6	0	2 0	2 8	0	0	0
0	0	0	0	1 2	1 2	0	1 6	1 6	2 8	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$
$h(n_1, n_2) * x(7,5)$	0 0 0 0 0 0 1 1 0 1 1 2 0 2 2 6 6 8
0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0
	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0
	0 0 0 0 0 0 0 0 0 0 0 0 0
	$h(n_1, n_2) * x(7,7)$
0 0 0 0 0 0 0 0 0 0 0 0 0	$h(n_1, n_2) * x(7,7)$
0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 1 8 8 8 4 4 8
	0 0 0 0 0 4 4 1 1 1 8 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 8 8 1 1 0 2 1
0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 8 1 1 1 8 4 0
h(n n ) . u(7 ()	0 0 0 0 0 0 0 1 8 0 1 2 2
$h(n_1, n_2) * x(7,6)$	0 0 0 0 0 0 0 1 8 1 0 2 2
0 0 0 0 1 1 8 8 4 4 8 0	2 6 0 8
0 0 0 0 0 4 4 1 1 1 8 0 0	2 2 6 6 8
0 0 0 0 8 8 1 1 0 2 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 8 1 1 1 8 4 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
6 2 2	0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 8 0 1 2 2 0 0 6 8 0 1 2 4 0	
$h(n_1, n_2) * x(6,1)$	0 0 9 9 0 1 1 2 0 0 0 0 0
0         0	0 0 0 0 0 0 0 0 0 0 0 0 0
1 1 1 1 5 5 1 0 0 0 0 0 0 0 0 0 0 0 0 0	
5 5 2 1 1 1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1         1         1         2         0         2         2         0         0         0         0         0	0 0 0 0 0 0 0 0 0 0 0 0
0 0 5 0 5 0 0 0 0 0 0 0 0	1( ) (( 2)
0         0         5         5         0	$h(n_1, n_2) * x(6,3)$
	0 0 0 0 0 0 0 0 0 0 0 0
0 1 1 2 0 2 3 0 0 0 0 0 0	0 0 6 6 4 4 2 2 4 0 0 0 0
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	0         0         2         2         8         6         6         4         0         0         0         0         0           0         0         4         4         6         8         0         10         8         0         0         0         0
0         0	0 0 4 8 6 6 4 2 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 8 4 0 6 12 10 0 0 0 0
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	0 0 0 6 4 8 0 10 14 0 0 0 0
1()((.2)	0 0 0 6 6 0 8 8 14 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
$h(n_1, n_2) * x(6,2)$	0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0
0 9 9 6 6 3 3 6 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 6 6 9 1 0 1 1 0 0 0 0 0	$h(n_1, n_2) * x(6,4)$
0 6 1 9 9 6 3 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 6 0 9 1 1 0 0 0 0 0	0         0
0 0 9 6 1 0 1 2 0 0 0 0 0	0         0         0         1         1         1         1         3         3         1         0         0         0           0

0	0	0	1	1	1	2	0	2	2	0	0	0
			0	0	5	0		5	0			
0	0	0	1	2	1	1	1	5	0	0	0	0
			0	0	5	5	0					
0	0	0	0	2	1	0	1	3	2	0	0	0
				0	0		5	0	5			
0	0	0	0	1	1	2	0	2	3	0	0	0
				5	0	0		5	5			
0	0	0	0	1	1	0	2	2	3	0	0	0
				5	5		0	0	5			
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2) *	$x(\theta)$	5,5)							
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	9	3	3	6	0	0					
0	0	0	0	3	3	1	9	9	6	0	0	0		
0	0	0	0	6	6	9	1	0	1	1	0	0		
							2		5	2				
0	0	0	0	6	1	9	9	6	3	0	0	0		
					2									
0	0	0	0	0	1	6	0	9	1	1	0	0		
					2				8	5				
0	0	0	0	0	9	6	1	0	1	2	0	0		
							2		5	1				
0	0	0	0	0	9	9	0	1	1	2	0	0		
								2	2	1				
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		

		h	$(n_1$	, n	·2) *	· x(	6,6)	)							
0	0 0 0 0 0 0 0 0 0 0 0 0 0														
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	1	1	8	8	4	4	8	0			
					2	2									

0	0	0	0	0	4	4	1	1 2	1 2	8	0	0
0	0	0	0	0	8	8	1 2	1 6	0	2 0	1	0
0	0	0	0	0	8	1	1 2	1 2	8	4	0	0
0	0	0	0	0	0	6 1 6	8	0	1 2	2 4	2 0	0
0	0	0	0	0	0	1 2	8	1	0	2 0	2 8	0
0	0	0	0	0	0	1 2	1 2	0	1 6	1 6	2 8	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$														
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0       0														
0	0     0														
	0 0 0 0 0 0 0 7 7 2 2 2 1 8 1 1 4 0 0 0 0 0 0 0 1 1 2 2 0 3														
0	0     0     0     0     0     7     7     2     2     2     1     4       0     0     0     0     0     1     1     2     2     0     3     2       4     4     1     8     5     8														
	0 0 0 0 0 0 0 1 1 2 2 0 3 5														
0	0 0 0 0 0 0 0 1 1 2 2 0 1 7 7 8 1 1 7 4 1 8 5 5 1 7 7 7 8 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7														
						4	4	1	8		5	8			
0	0	0	0	0	0	1	2	2	2	1	7	0			
						4	8	1	1	4					
0	0	0	0	0	0	0	2	1	0	2	4	-			
							8	4		1		5			
0	0	0	0	0	0	0	2	1	2	0	3	4			
							1	4	8		5	9			
0	0	0	0	0	0	0	2	2	0	2	2	4			
							1	1		8	8	9			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0	0	0	0	0	0			

		h(n	<sub>1</sub> , n	·2) *	x(!	5,1)						
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	5	5	1	0	0	0	0	0	0
5	5	2	0	1	1	0	0	0	0	0	0	0
3	)	0	5	5	0	0	U	U	U	U	0	U
1	1	1	2	0	2	2	0	0	0	0	0	0
0	0	5	0		5	0						
1	2	1	1	1	5	0	0	0	0	0	0	0
0	0	5	5	0								
0	2	1	0	1	3	2	0	0	0	0	0	0
	0	0		5	0	5						
0	1	1	2	0	2	3	0	0	0	0	0	0
	5	0	0		5	5						
0	1	1	0	2	2	3	0	0	0	0	0	0
	5	5		0	0	5						
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h(r)	$\iota_1$ , $\iota$	$n_2$	* X(	[5, 2]	)					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

																									==
					x(!								0	0	0	0	0	0	0	0	0	0	0	0	0
)	0	0	0	0	0	0	0	0	0	0	0	0	0	1 2	1 2	8	8	4	4	8	0	0	0	0	0
)	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	1	1	1	8	0	0	0	0	0	0
)	0	0	0	0	0	0	0	0	0	0	0	0				6	2	2							
	1	1	1	5	5	1	0	0	0	0	0	Λ	0	8	8	1	1	0	2	1	0	0	0	0	0
	5	0	0	3	3	0	U	U	U	U	0	U				2	6		0	6					
	5	2	1	1	1	0	0	0	0	0	0	0	0	8	1	1	1	8	4	0	0	0	0	0	0
		0	5	5	0		U	U	U	0	0	U			6	2	2								
	1	1	2	0	2	2	0	0	0	0	0	Λ	0	0	1	8	0	1	2	2	0	0	0	0	0
,	0	5	0	U	5	0	U	U	U	U	U	U			6			2	4	0					
	2	1	1	1	5	0	0	0	0	0	0	0	0	0	1	8	1	0	2	2	0	0	0	0	0
	0	5	5	0	5	U	U	U	U	U	U	U			2		6		0	8					
	2	1	0	1	3	2	0	0	0	0	0	Λ	0	0	1	1	0	1	1	2	0	0	0	0	0
'	2	0	U	5	_	5	0	0	U	0	U	U			2	2		6	6	8					
	1	1	-	5	0	2	0	0	0	0	_		0	0	0	0	0	0	0	0	0	0	0	0	0
'	1 -	1	2	0	2	5	U	0	U	U	0	U	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	1	0	2	2	2	0	0	0	0	0	^	0	0	0	0	0	0	0	0	0	0	0	0	0
'	1 ~	1 ~	U	2	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	)	5		U	U	)	1							•	•		•	•							

		h	$(n_1$	, n	<sub>2</sub> ) :	* X	(5,3)	3)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	6	6	4	4	2	2	4	0	0	0	0
0	0	2	2	8	6	6	4	0	0	0	0	0
0	0	4	4	6	8	0	10	8	0	0	0	0

0	0	4	8	6	6	4	2	0	0	0	0	0
0	0	0	8	4	0	6	12	10	0	0	0	0
0	0	0	6	4	8	0	10	14	0	0	0	0
0	0	0	6	6	0	8	8	14	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(5,	4)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(5,	5)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(4,	1)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

				$n_2$								
0	0	0	0	0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	( <sub>2</sub> ) *	x(!	5,6)	)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1 2	1 2	8	8	4	4	8	0
0	0	0	0	0	4	4	1	1 2	1 2	8	0	0
0	0	0	0	0	8	8	1 2	1 6	0	2 0	1	0
0	0	0	0	0	8	1	1 2	1 2	8	4	0	0
0	0	0	0	0	0	1 6	8	0	1 2	2 4	2 0	0
0	0	0	0	0	0	1 2	8	1 6	0	2 0	2 8	0
0	0	0	0	0	0	1 2	1 2	0	1	1	2 8	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(5,	7)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

===	====						====	===	====			==
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	1	8	8	4	4	8	0	0	0	0	0
	2	2										
0	4	4	1	1	1	8	0	0	0	0	0	0
			6	2	2							
0	8	8	1	1	0	2	1	0	0	0	0	0
			2	6		0	6					
0	8	1	1	1	8	4	0	0	0	0	0	0
		6	2	2								
0	0	1	8	0	1	2	2	0	0	0	0	0
		6			2	4	0					
0	0	1	8	1	0	2	2	0	0	0	0	0
		2		6		0	8					
0	0	1	1	0	1	1	2	0	0	0	0	0
		2	2		6	6	8					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

$$h(n_1, n_2) * x(4,3)$$

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	3	3	2	2	1	1	2	0	0	0	0
0	0	1	1	4	3	3	2	0	0	0	0	0
0	0	2	2	3	4	0	5	4	0	0	0	0
0	0	2	4	3	3	2	1	0	0	0	0	0
0	0	0	4	2	0	3	6	5	0	0	0	0
0	0	0	3	2	4	0	5	7	0	0	0	0
0	0	0	3	3	0	4	4	7	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	$, n_2$	) * 2	κ(4,	4)					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	8	8	4	4	8	0	0	0
			2	2								
0	0	0	4	4	1	1	1	8	0	0	0	0
					6	2	2					
0	0	0	8	8	1	1	0	2	1	0	0	0
					2	6		0	6			
0	0	0	8	1	1	1	8	4	0	0	0	0
				6	2	2						
0	0	0	0	1	8	0	1	2	2	0	0	0
				6			2	4	0			
0	0	0	0	1	8	1	0	2	2	0	0	0
				2		6		0	8			
0	0	0	0	1	1	0	1	1	2	0	0	0
				2	2		6	6	8			
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(4,	5)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(4,	6)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	<sub>2</sub> )	* x(	[4, 7	<b>'</b> )				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	2	1	1	8	8	1
						4	4	6	6			6
0	0	0	0	0	0	8	8	3	2	2	1	0
								2	4	4	6	
0	0	0	0	0	0	1	1	2	3	0	4	3
						6	6	4	2		0	2
0	0	0	0	0	0	1	3	2	2	1	8	0
						6	2	4	4	6		
0	0	0	0	0	0	0	3	1	0	2	4	4
							2	6		4	8	0
0	0	0	0	0	0	0	2	1	3	0	4	5
							4	6	2		0	6
0	0	0	0	0	0	0	2	2	0	3	3	5
							4	4		2	2	6
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h(r	$\iota_1$ , $r$	$\iota_2)$ ;	* X(	3,1)	)					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
9	9	6	6	3	3	6	0	0	0	0	0	0
3	3	1 2	9	9	6	0	0	0	0	0	0	0
6	6	9	1 2	0	1 5	1 2	0	0	0	0	0	0
6	1 2	9	9	6	3	0	0	0	0	0	0	0
0	1 2	6	0	9	1 8	1 5	0	0	0	0	0	0
0	9	6	1 2	0	1 5	2	0	0	0	0	0	0

====					====	====			===	====		===	<u></u>				====				===				==_
		h(r)	$l_1$ , $\gamma$	$\iota_2)$ ;	* x(	3,1	)						0	9	9	0	1	1	2	0	0	0	0	0	0
0	Λ	0	T)	0	<u> </u>	l n	n	Λ	Λ	Λ	Ω	Λ					2	2	1						
U	U	U	U	U	U	U	U	U	O	U	U	U	0	0	0	0	0	0	0	0	0	0	0	0	0
0	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ													
U	0	U	0	U	U	U	U	0	0	U	U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Λ	Λ	0	Λ	0	Ω	0	Ω	Λ	0	0	Ω	0													

		h(	$n_1$ ,	$n_2$	* X	(3, 2)	2)					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	9	9	6	6	3	3	6	0	0	0	0	0
0	3	3	1 2	9	9	6	0	0	0	0	0	0
0	6	6	9	1 2	0	1 5	1 2	0	0	0	0	0
0	6	1	9	9	6	3	0	0	0	0	0	0

		2										
0	0	1	6	0	9	1	1	0	0	0	0	0
		2				8	5					
0	0	9	6	1	0	1	2	0	0	0	0	0
				2		5	1					
0	0	9	9	0	1	1	2	0	0	0	0	0
					2	2	1					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(3,3)	3)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	6	6	4	4	2	2	4	0	0	0	0
0	0	2	2	8	6	6	4	0	0	0	0	0
0	0	4	4	6	8	0	10	8	0	0	0	0
0	0	4	8	6	6	4	2	0	0	0	0	0
0	0	0	8	4	0	6	12	10	0	0	0	0
0	0	0	6	4	8	0	10	14	0	0	0	0
0	0	0	6	6	0	8	8	14	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(3,	4)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(3,	5)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	6	6	4	4	2	2	4	0	0
0	0	0	0	2	2	8	6	6	4	0	0	0

===			===							===		
		h	$(n_1$	, n	2)	* X	(2,	1)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

0	0	0	0	4	4	6	8	0	10	8	0	0
0	0	0	0	4	8	6	6	4	2	0	0	0
0	0	0	0	0	8	4	0	6	12	10	0	0
0	0	0	0	0	6	4	8	0	10	14	0	0
0	0	0	0	0	6	6	0	8	8	14	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	<sub>2</sub> ) *	x(	3,6)	)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1 2	1 2	8	8	4	4	8	0
0	0	0	0	0	4	4	1 6	1 2	1 2	8	0	0
0	0	0	0	0	8	8	1 2	1 6	0	2 0	1 6	0
0	0	0	0	0	8	1 6	1 2	1 2	8	4	0	0
0	0	0	0	0	0	1 6	8	0	1 2	2 4	2 0	0
0	0	0	0	0	0	1 2	8	1 6	0	2 0	2 8	0
0	0	0	0	0	0	1 2	1 2	0	1 6	1	2 8	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	(2)	* X(	[3, 7]	)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1	1	1	5	5	1
						5	5	0	0			0
0	0	0	0	0	0	5	5	2	1	1	1	0
								0	5	5	0	
0	0	0	0	0	0	1	1	1	2	0	2	2
						0	0	5	0		5	0
0	0	0	0	0	0	1	2	1	1	1	5	0
						0	0	5	5	0		
0	0	0	0	0	0	0	2	1	0	1	3	2
							0	0		5	0	5
0	0	0	0	0	0	0	1	1	2	0	2	3
							5	0	0		5	5
0	0	0	0	0	0	0	1	1	0	2	2	3
							5	5		0	0	5
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(2,	2)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	3	3	2	2	1	1	2	0	0	0	0	0

0	1	1	4	3	3	2	0	0	0	0	0	0
0	2	2	3	4	0	5	4	0	0	0	0	0
0	2	4	3	3	2	1	0	0	0	0	0	0
0	0	4	2	0	3	6	5	0	0	0	0	0
0	0	3	2	4	0	5	7	0	0	0	0	0
0	0	3	3	0	4	4	7	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1)$	$, n_2$	) * x	c(2,	3)					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	9	9	6	6	3	3	6	0	0	0	0
0	0	3	3	1 2	9	9	6	0	0	0	0	0
0	0	6	6	9	1 2	0	1 5	1 2	0	0	0	0
0	0	6	1 2	9	9	6	3	0	0	0	0	0
0	0	0	1 2	6	0	9	1 8	1 5	0	0	0	0
0	0	0	9	6	1 2	0	1 5	2	0	0	0	0
0	0	0	9	9	0	1 2	1 2	2	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	$n_2$	) * 2	χ(2,	4)					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	8	8	4	4	8	0	0	0
			2	2								
0	0	0	4	4	1	1	1	8	0	0	0	0
					6	2	2					
0	0	0	8	8	1	1	0	2	1	0	0	0
					2	6		0	6			
0	0	0	8	1	1	1	8	4	0	0	0	0
				6	2	2						
0	0	0	0	1	8	0	1	2	2	0	0	0
				6			2	4	0			
0	0	0	0	1	8	1	0	2	2	0	0	0
				2		6		0	8			
0	0	0	0	1	1	0	1	1	2	0	0	0
				2	2		6	6	8			
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(2,	5)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	· <sub>2</sub> ) *	x(1)	2,6)	)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	1	8	8	4	4	8	0
					2	2						
0	0	0	0	0	4	4	1	1	1	8	0	0
							6	2	2			
0	0	0	0	0	8	8	1	1	0	2	1	0
							2	6		0	6	
0	0	0	0	0	8	1	1	1	8	4	0	0
						6	2	2				
0	0	0	0	0	0	1	8	0	1	2	2	0
						6			2	4	0	
0	0	0	0	0	0	1	8	1	0	2	2	0
						2		6		0	8	
0	0	0	0	0	0	1	1	0	1	1	2	0
						2	2		6	6	8	
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	, n	<sub>2</sub> )	* X(	2,7	)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1	1	1	6	6	1
						8	8	2	2			2
0	0	0	0	0	0	6	6	2	1	1	1	0
								4	8	8	2	
0	0	0	0	0	0	1	1	1	2	0	3	2
						2	2	8	4		0	4
0	0	0	0	0	0	1	2	1	1	1	6	0
						2	4	8	8	2		
0	0	0	0	0	0	0	2	1	0	1	3	3
							4	2		8	6	0
0	0	0	0	0	0	0	1	1	2	0	3	4
							8	2	4		0	2
0	0	0	0	0	0	0	1	1	0	2	2	4
							8	8		4	4	2
0	0	0	0	0	0	0	0	0	0	0	0	0

	$h(n_1, n_2) * x(1, 1)$													
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0	0	0	0	0	0		

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

				$n_2$								
0	0	0	0	0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	1 2	1 2	8	8	4	4	8	0	0	0	0	0
0	4	4	1 6	1 2	1 2	8	0	0	0	0	0	0
0	8	8	1 2	1 6	0	2 0	1 6	0	0	0	0	0
0	8	1	1 2	1 2	8	4	0	0	0	0	0	0
0	0	1 6	8	0	1 2	2 4	2 0	0	0	0	0	0
0	0	1 2	8	1 6	0	2 0	2 8	0	0	0	0	0
0	0	1 2	1 2	0	1 6	1 6	2 8	0	0	0	0	0

		h	$(n_1$	, n	2)	* X	(1,	3)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

		h	$(n_1$	$n_2$	) * ɔ	κ(1,	4)					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	5	5	1	0	0	0
			5	5	0	0			0			
0	0	0	5	5	2	1	1	1	0	0	0	0
					0	5	5	0				
0	0	0	1	1	1	2	0	2	2	0	0	0
			0	0	5	0		5	0			
0	0	0	1	2	1	1	1	5	0	0	0	0
			0	0	5	5	0					
0	0	0	0	2	1	0	1	3	2	0	0	0
				0	0		5	0	5			
0	0	0	0	1	1	2	0	2	3	0	0	0
				5	0	0		5	5			

0	0	0	0	1	1	0	2	2	3	0	0	0
				5	5		0	0	5			

		h	$(n_1$	$, n_2$	* (2	x(1	,5)					
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	1	1	5	5	1	0	0
				5	5	0	0			0		
0	0	0	0	5	5	2	1	1	1	0	0	0
						0	5	5	0			
0	0	0	0	1	1	1	2	0	2	2	0	0
				0	0	5	0		5	0		
0	0	0	0	1	2	1	1	1	5	0	0	0
				0	0	5	5	0				
0	0	0	0	0	2	1	0	1	3	2	0	0
					0	0		5	0	5		
0	0	0	0	0	1	1	2	0	2	3	0	0
					5	0	0		5	5		
0	0	0	0	0	1	1	0	2	2	3	0	0
					5	5		0	0	5		

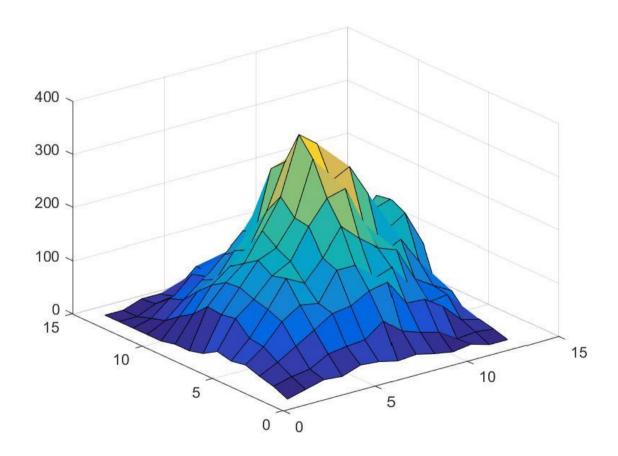
		h	$(n_1$	, n	<sub>2</sub> ) :	* X	(1,	6)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

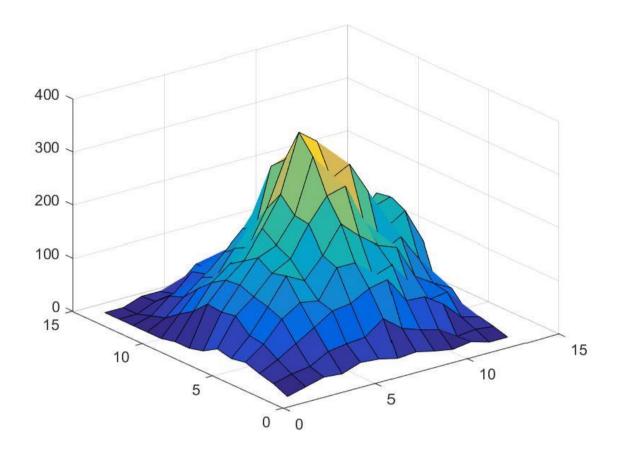
		h	$(n_1$	, n	2)	* <i>x</i>	(1,	7)				
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

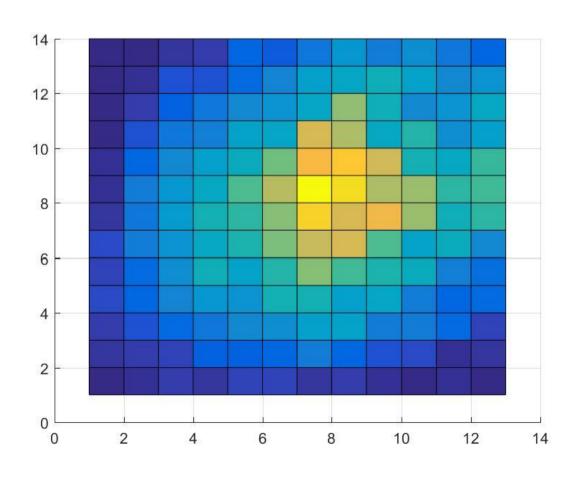
		$y(n_1$	$,n_2)$	)								
0	9	18	15	27	24	16	19	11	5	10	0	0
12	21	26	45	50	53	79	51	39	30	8	12	8
19	36	57	78	100	105	124	131	82	80	57	23	14
28	53	91	113	107	160	160	125	137	80	53	58	16
23	57	102	151	133	171	220	188	162	149	85	63	44
29	82	109	144	162	217	261	270	195	129	146	96	30
13	77	119	161	175	221	323	272	290	230	152	174	107
6	80	116	143	194	249	357	330	242	233	177	188	97
6	54	99	125	147	209	293	311	264	158	143	183	113
0	37	75	88	133	139	268	243	142	171	101	124	81
0	17	47	75	95	111	137	226	153	95	108	141	121
0	9	37	34	60	92	126	139	151	131	95	106	77
0	0	15	20	52	41	78	113	80	104	75	52	42
0	0	12	12	15	46	31	48	40	55	35	0	0

# Графическое представление выходного сигнала

Графики построены в среде MatLab R2016a.







# Выводы

В ходе работы была найдена реакция импульсного отклика ЛИС-системы  $h(n_1,n_2)$  на входной сигнал  $x(n_1,n_2)$  двумя способами:

- 1) с помощью дискретной свертки:  $y(n_1, n_2) = h(n_1, n_2) ** x(n_1, n_2);$
- 2) путем суммирования взвешенных и сдвинутых импульсных откликов;

Для этого были написаны программы для вычисления реакции  $y(n_1,n_2)$  системы двумя вышеперечисленными способами на языке C++. Результирующие массивы  $y(n_1,n_2)$  получились идентичными в обоих случаях, что подтверждает достоверность вычислений. Также были построены 3D графики для  $y(n_1,n_2)$  для визуализации многомерного выходного сигнала.